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ES-102 GPS BASED
TIME CODE GENERATOR / MASTER CLOCK

OPERATION AND MAINTENANCE MANUAL

The ES-102 is a GPS Master Clock/Time Code Generator. The unit receives accurate time and date information from Global Positioning System satellites and supplies this data to the user in the form of four (4) different types of time code (SMPTE/EBU, ASCII, TC89 and TC90) and a front panel six-digit display (.56" yellow LEDs). Two (2) One Pulse Per Second outputs and a GPS "Lock" output are also available. A twelve-channel receiver is employed that is capable of tracking up to twelve (12) satellites simultaneously, although reception of only one is required for time data to be output.

Several options are available that allow the unit to meet most any requirement asked from a Master Clock or Time Code Generator. These options are described in the "OPTIONS" section.

INSTALLATION & OPERATION

The basic installation of the ES-102 is nearly as simple as connecting the Antenna Cable and 117 VAC to the unit, and allowing the unit to "lock" onto GPS. However, after any "bench" testing is complete, the most important concern is to mount the Antenna and route the cable according to the instructions provided on page 7.

All other connections between the ES-102 and other equipment should be made by a qualified technician or engineer. The technician or engineer should be familiar with each piece of equipment being interfaced with the ES-102. Please refer to the descriptions and specifications for details concerning the various Standard Features, Setup Features and Options. Consult the manufacturer of the equipment or the ESE factory if assistance is required.

A lithium coin cell battery maintains the settings of the GPS receiver during periods without power. The battery is capable of maintaining the settings for up to four years. If the receiver needs re-initialization, refer to the master clock software program descriptions on page 11.

STANDARD FEATURES

Power Supply

The ES-102 is equipped with an internal Power Supply. The Power Supply requires 117 VAC via the 3-wire line cord.

Display

The front-panel contains a single green LED that indicates if the unit is "Locked" to GPS. When locked to GPS, the LED remains lit. Prior to lock or when lock is lost, the LED blinks at a 1 Hz rate. The ES-102 also has a six-digit .56" high yellow LED display.

Outputs

The rear-panel of the ES-102 provides access to the time codes, 1PPS and GPS Lock outputs via XLR, BNC and DB-9 connectors. Please refer to the "Rear Panel DB-9 Connector Pin Designations" and "Specifications" for more details.

EBU: The ES-102 can have an EBU Time Code output specified. The EBU Time Code Output is accessible via an XLR connector. Accuracy of the EBU is +/- 400 mS and can be synchronized to a video source via the "Video In" BNC connector. The EBU time code is automatically "re-synched" to GPS at 2:00:00 AM. EBU (European Broadcasting Union) is used predominantly in Europe in the TV, Cable and Video industries.

SMPTE: The ES-102 can have a SMPTE Time Code output specified. The SMPTE Time Code Output is accessible via an XLR connector. Accuracy of the SMPTE is +/- 400 mS and can be synchronized to a video source via the "Video In" BNC connector. The SMPTE time code is automatically "re-synched" to GPS at 2:00:00 AM. SMPTE (Society of Motion Picture and Television Engineers) is used predominantly in the TV, Cable and Video industries. The SMPTE User Bits are, from high to low, as follows: 1OY-X-Y-X-10M/10D-M-D-X. When Julian Day of Year is used, the SMPTE User Bits are as follows: X-X-X-X-X-100D-10D-D.

Drop Frame: Unless otherwise specified, the unit is set to provide "Drop Frame" SMPTE Time Code. If non-Drop Frame SMPTE is desired, turn "ON" the "NDF" DIP switch (switch #7 on the ES-101 logic board).

Date: The date information encoded into the "user bits" of the SMPTE time code is typically set to include Month-Day-Year information. Turning “ON” the "DOY" DIP switch (switch #5 on the ES-101 logic board) reformats the data to contain Day of Year (001-366) instead of Month-Day-Year.

ESE Time Code: The most efficient and cost-effective method for time code distribution in a Master Clock/Remote Clock System employs the ESE Time Code output. ESE Time Code is capable of driving up to 100 remote displays at a distance of up to 4000 feet. Connections (between the ES-102 ESE Time Code Output and any ESE Time Code Reader) can be made using twisted pair wire or coax cable such as RG-58 or RG-59. The accuracy is 17mS of UTC and the time code is accessible on two separate BNC connectors (TC89 & TC90). TC89 is an older version of ESE Time Code and should be used to drive older ESE Time Code Readers (non-”A” versions). TC90 contains “Date” information as well as time data and should be used if “Date” is to be displayed on the Reader.

RS-232C: RS-232C ASCII Time Code is used to interface with a PC or other computer system. The ASCII transmission contains date and time data and is transmitted once per second. The data is accessible on the DB-9 connector. Windows® and DOS software included with the unit enables the ES-102 to continuously update a computer’s clock. (Software is also available from the ESE Web-Site at **http://www.ESE-WEB.com**.)

GPS “Lock”: Access to a TTL output of GPS "Lock" information is accessible on the DB-9 connector. When locked the signal goes to a logic “1”.

1PPS: The most accurate time information available from the ES-102 is that provided by the 1PPS Output (one pulse per second). Two (2) outputs are provided: a 20% duty signal specified as being within 500ns of UTC, and a 50% duty signal which is within 1mS of UTC. The 20% duty signal is obtained directly from the receiver. The 50% duty signal is regenerated by the timekeeping microprocessor; this signal is isolated from dropouts due to signal loss and should be used for long-term timekeeping purposes. Both signals are positive edge true. The 1PPS can be used for synchronization purposes in a variety of applications. One such application allows the 1PPS to drive an Impulse Driver (ES-165 or ES-162A) which, in turn, can drive "Analog" Impulse Clocks (ES-168 or ES-162S).

Battery

The ES-102 has a lithium coin cell battery that maintains certain receiver configuration settings during power outages, storage or shipment. The battery is capable of maintaining these settings for up to four years. All outputs, however, are suspended during a power outage. If continuous outputs during power outages are required, a UPS (Uninterruptable Power Supply) is suggested. Option “BBU” is available and is capable of maintaining power to all outputs during a power outage for up to four hours.

Antenna

An "active" GPS Antenna (1.575 GHz) with 16’ 5” cable is supplied with the ES-102 and connects to the unit via a TNC connector. ESE has conducted a series of tests with the purpose of determining a maximum cable length (with or without amplification). A summary of the tests and the alternatives are discussed on page 8. Proper installation of the antenna module is imperative for proper operation and continued life of the antenna and clock. See page 7.

Enclosure

The ES-102 is housed in a rack-mount enclosure that measures 1.75" high x 19" wide x 9.5" deep (plus connectors). The ruggedized enclosure is constructed of etched and clear anodized aluminum.

SETUP FEATURES

Several features of the ES-102 are factory set according to information supplied by the end user or according to factory standards. All Setup Features are selected via DIP switches except "Time Zone", "Time Delay/Advance" and "Cable Delay". All Setup Features are discussed below.

Time Zone: The ES-102 receives GPS time and date information which has been encoded and set to UTC (Universal Coordinated Time/Greenwich Mean Time). The unit must be set at the factory to decode and output time for the end-user's time zone. Or, by using the software supplied with the ES-102, the time-zone can be changed "in the field". This is accomplished by connecting the RS-232C input to a computer serial port and running the ESEGPS (Windows®) or GPSINI.EXE (DOS) programs. Running GPSINI.EXE without command line switches will print the instructions on screen. Run the GPSINI.EXE program again using the appropriate command line parameters. Please connect ONLY the 2 data lines & the ground line to the computer: the DB-9 connector also provides access

to unrelated functions which should not be connected to the computer. (Software is also available from the ESE Web-Site at **http://www.ESE-WEB.com**.)

12/24 Hr: The ESE “TC89” Time Code can be output in either 12 hour or 24 hour format. This enables Remote Clocks to differ from the Master. Turn “ON” the “24 HR” DIP switch (switch #4 on the ES-101 logic board) for 24 hour operation. Note: Most ESE Serial Time Code Reader Clocks can be programmed for either 12 hour or 24 hour format regardless of the “TC89” format. To set the display for 12 hour format, turn on DIP switch #4 on the ES-USS display logic board.

DST: DST (Daylight Savings Time) can automatically be compensated for if the end-user desires. Turning “ON” the "DST" DIP switch (switch #6 on the ES-101 logic board) enables the DST feature. The DST adjustment is according to the standards used in the United States and switches at 2:00 AM. Foreign DST standards are available on a "custom" basis.

Date: The date information encoded into the SMPTE time code is typically set to include Month-Day-Year information. Turning “ON” the “DOY” DIP switch (switch #5 on the ES-101 logic board) reformats the data to contain Day of Year (001-366) instead of Month-Day-Year.

OPTIONS

The rear-panel of the ES-102 provides access to all "Optional" inputs and outputs via various connectors (BNC & DB-9). Please refer to the "Rear Panel DB-9 Connector Pin Designations" and "Specifications" for more details.

Time Codes

B: Option "B" provides a parallel BCD Output of the time data. The data is CMOS compatible and contains 20 Data Lines (10’s Hours thru Seconds) and Ground. Applications requiring Parallel BCD require an ES-169B (Serial To Parallel Time Code Converter) to be ordered separately.

Frequency Outputs

K: Option "K" provides a 1 KHz square wave, a 10 MHz sine wave and a phase coherent 1 PPS output. The 1 PPS output has a 50% duty cycle and replaces the standard 50% duty cycle 1 PPS output. The 1 KHz and 10 MHz outputs are accessible on BNC connectors. The sine wave is 4 Vpp into 50 ohms. Potentiometer R6 allows the output level of the sine wave to be adjusted by +/- 0.5 volts. The square wave is 5 Vpp. A front panel 10 MHz Lock LED is provided. This LED lights solid to indicate that the unit has “locked” to GPS and the outputs are within specifications. The 1 PPS output is phase coherent when the 10 MHz Lock LED lights solid. The LED blinks if GPS “lock” has been obtained, but the outputs are out of specifications. If “lock” has not been obtained, the LED does not light. Option ‘45ηS’ is required.

The Option “K” system functions independently from the rest of the clock, although it receives its input from the same GPS receiver as the clock system. When first powered up, the receiver searches for satellites. When it locks on to at least one, the GPS Lock LED indicates a locked condition by lighting solidly. The 10 MHz Lock LED begins flashing after a delay of about 40 seconds. The flashing of this LED indicates that the GPS receiver is locked and that the 10 MHz system is in the process of adjusting the frequency of the 10 MHz output. This process may take up to 1 hour. During this time the frequency, if measured, may indicate 100 – 200 Hz off. This is normal during the locking process. While the 10 MHz Lock LED is flashing, the output should not be used as a reference. When this LED lights solidly, the output is within tolerance.

The ES-110M12 PCB generates the Option “K” outputs – 10 MHz & 1 KHz. The PCB receives 1 Hz and satellite data from the GPS receiver on the main PCB. +12v & +5v power is also supplied to the 110M12 board. The system consists of a TCXO (temperature-compensated crystal oscillator), counter chain, phase detector, loop filter and supervisory microcontroller (Z2). The 20 MHz oscillator is divided by the counter chain (Z7-Z12 & part of Z5) down to 1 Hz. The phase-detector chip (Z4) receives this signal and the 1 Hz signal from the GPS receiver. Z4 produces an output which is fed to the loop filter, consisting of analog switch Z3, resistors R15 - R17, capacitors C22 - C23 and op-amp Z17. The analog switch allows the microcontroller to control the time constant of the filter and also disable the loop during periods of non-reception of satellites. The filtered control voltage is fed to the frequency control input of the TCXO. This functions as a phase locked loop, controlling the frequency and phase of the oscillator from the GPS reference 1 Hz. The satellite data from the GPS is fed to the microcontroller UART input, allowing the system to know if the receiver is locked to satellites. The microcontroller also monitors an output from the phase detector chip to determine the amount of phase difference between the GPS and the internally divided 1Hz. If it is greater than approximately 40 milliseconds, the microcontroller “gear shifts” the counter chain fast or slow to bring the relative phase to under 40 mS. This procedure is performed during initial lock-on, or if reception of satellites is lost for a significant time and enough drift occurs. After rough phase adjustment is performed, the oscillator frequency remains either fast or slow by about 100-200 Hz until the local 1 Hz arrives in

phase with the GPS 1 Hz. This typically takes up to 1 hour. During this time, the 10 MHz Lock LED flashes. The frequency then stabilizes at the center frequency of 20 MHz (it is divided by 2 for the output). After stabilization, the 10 MHz Lock LED lights solidly. The 10 MHz output is filtered to a sine-wave and buffered by op-amp Z14. The microcontroller generates the 1 KHz signal, which is buffered by Z1.

HR: Option "Hr" provides a relay contact closure on the Hour and on the Half-Hour. An internal DIP switch (switch #3 on the ES-101 logic board) can be turned “ON” if a closure on the Hour ONLY is required (Hr & 1/2 Hr is supplied unless otherwise specified). The reed relay is rated at 10 watts maximum resistive load (500mA switching current) and is intended for control applications only. Relay contacts are accessible on the DB-9 connector.

Miscellaneous

ANT: A high performance antenna for challenging EMI environments is provided with this option. Nineteen feet of cable is supplied with the antenna.

BBU: The ES-102 can be ordered with built-in Battery Back-Up/Charger System. Option ‘P’ is required. The battery is capable of maintaining the time code outputs during a power outage for up to 4 hours. Displays, if ordered are blank during a power outage. If continuous displays during power outages are required, a UPS (Uninterruptable Power Supply) is suggested. Note: Turn off the battery during shipment or any extended periods of time without main power.

DC: The ES-102 can be ordered from the factory to operate exclusively from a DC source. The voltage applied must be in the range from +12 VDC to +36 VDC. A 2 amp fuse is provided.

J: The standard ES-102 is intended to operate from 117 VAC 50/60 Hz. If 220 VAC operation is required, Option "J" must be specified.

UL: When Option “UL” is specified, the unit’s power transformer is external to the unit, ie: a “wall wart” type UL/CSA approved transformer is supplied. This option allows the ES-102 to be installed in facilities requiring “UL” (or equivalent) approved equipment.

45ηS: The ES-102 can be ordered with improved accuracy. When so specified, the unit delivers a 1PPS accuracy of <45ηS. Also, when the **45ηS** option is specified, two (2) additional Setup Features are available and are described below.

Time Delay: This program allows the ES-102 to provide an advanced or delayed time output. Time can be adjusted +/-400mS. Refer to the "readme.txt" file on the provided CD for more details.

Cable Delay: This program allows the ES-102 to compensate for antenna cable delay, adjustable for 0 - 22,215 feet. Refer to the "readme.txt" file on the provided CD for more details.

SPECIFICATIONS

GPS RECEIVER: Motorola 12-channel

1 PPS OUTPUTS: DB-9 connector, TTL outputs, positive edge true:
#1 - 20% duty output <500nS accuracy, directly from receiver
#2 - 50% duty output < 1mS accuracy, regenerated

ESE TC OUTPUT: BNC, drives 100 readers, 4000' cable maximum
TC89 - drives non-"A" version Readers
TC90 - drives "Date" Readers and/or "A" version Readers

SMPTE/EBU TC OUTPUT: XLR, 600Ω balanced or unbalanced

RS-232C OUTPUT: DB-9 connector, ASCII Date & Time, sent once per second

RS-232C FORMAT: ESE Format "A"
ASCII @ 9600 Baud, 8 Data, No Parity, 1 Stop
MM-DD-YY<SPACE><SPACE>DDD:HH:MM:SS<CR>
Transmission is once per second and ends 7 mS before Time True.

VIDEO INPUT: BNC, RS-170 composite video / blackburst, 1 VPP, 75Ω

ACCURACY: 1PPS @ < 500nS
ESE TC @ 17mS
SMPTE/EBU @ 0 frames with respect to video sync, +/- 400 mS if free running (due to Drop Frame compensation)

DRIFT: 33mS/Day

POWER: 117 VAC, 50/60 Hz, 15 Watts typical

MECHANICAL: Rack Mount Enclosure 1.75" H x 19" W x 9.5" D (plus connectors)

OPTION K: 10 MHz Sine wave, BNC, 4 Vpp into 50 ohms (adjustable +/- 0.5V)
1 KHz Square wave, BNC, 5 Vpp CMOS/TTL
1 PPS, 50% duty cycle, DB-9 (pin 5), 5 Vpp CMOS/TTL, < 2 µS of GPS when 10 MHz lock LED is solid

REAR PANEL DB-9 CONNECTOR PIN DESIGNATIONS

Pin	Function
1	+12 VDC - +36 VDC Input (option "DC" only)
2	RS-232 TXD
3	RS-232 RXD
4	1 PPS (20 % duty)
5	1 PPS (50 % duty)
6	Relay (Hr opt)
7	Relay (Hr opt)
8	GPS Lock
9	Ground

DIP SWITCH SETTINGS

ES-101 Logic Board

Switch	Function (if switch is "ON")
1	Mode (see table below)
2	Mode (see table below)
3	Relay Closure on the Hour only
4	TC89 24HR output
5	DOY output
6	Daylight Savings On
7	Non-Drop Frame
8	Not Used

ES-USS Logic Board (Display Logic Board)

Switch	Function (if switch is "ON")
1	Date
2	Not Used
3	Not Used
4	12 Hour Format
5	9 Digit Display
6	Not Used
7	Not Used
8	Not Used

ES-101 Logic Board Mode Switches

Mode	Switch 1	Switch 2
IRIG-B	OFF	OFF
IRIG-E	OFF	ON
SMPTE	ON	OFF
EBU	ON	ON

TEMPLATE FOR ANTENNA/MOUNTING PLATE

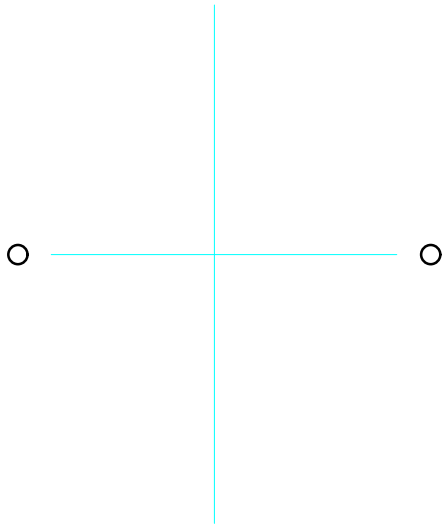


Figure 1.

Note: The Antenna Mounting Plate can also be used as a Template.

ANTENNA With LA-12F And 150' Of EXTRA CABLE (RG-58)

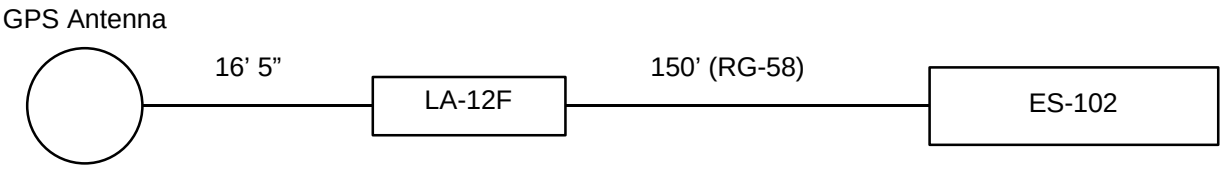


Figure 2.

ANTENNA With 5) LA-12FN And 500' Of EXTRA CABLE (RG-8) With ES-AB1A

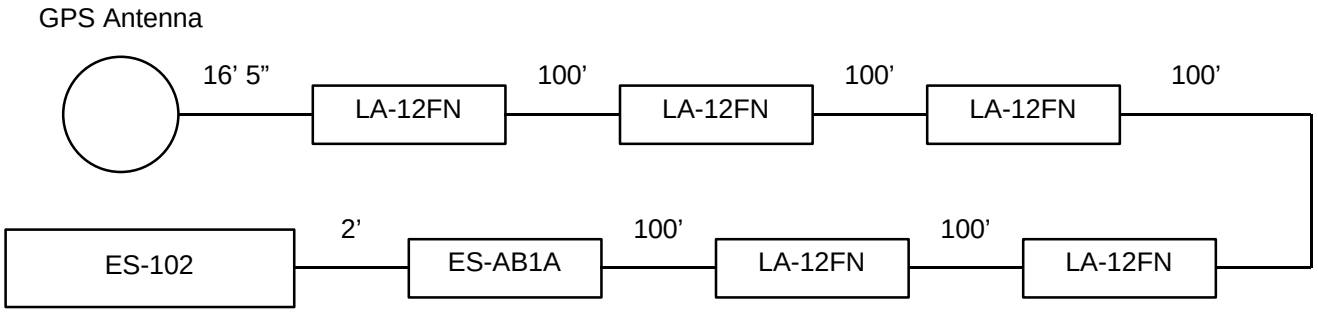


Figure 3.

ANTENNA MOUNTING INSTRUCTIONS

Refer to Figure 1 on Page 6 and perform the following steps to install the Direct Mount Antenna.

1. Locate a spot that allows the Antenna a view of the sky and where the antenna can be mounted according to the instructions that follow. Note: It is advised to test the Antenna at the location where it is to be mounted prior to mounting (and drilling holes) to verify proper operation.
2. Two 1/8” holes on the mounting plate are used to mount the antenna. Two #4 screws can be used to secure the mounting plate. If using plastic anchors, drill two holes of the appropriate diameter and depth (using the template provided on page 6) through the deck plane where you are mounting the antenna.
3. Press into each hole a plastic anchor until the top of the anchor is flush with the deck plane.
4. Drill a 5/8" hole (for the antenna connector/cable) slightly below where the antenna is to be mounted.
5. Route the antenna connector/cable through the 5/8" hole and then fasten the Antenna to the deck plane using two (2) #4 screws.
6. Connect the antenna connector/cable to the "Antenna" connector on the rear panel of the ES-102 Master Clock.
7. Fill the hole (through which the antenna connector/cable was routed) with an all-weather caulking compound.

Note: If desired, the Antenna can be "magnet mounted" to any steel or other appropriate surface. The mounting plate should be removed from the Antenna. The magnet is mounted to the Antenna.

ANTENNA CABLE TESTS & ALTERNATIVES

The antenna supplied with the ES-102 is designed to provide excellent reception under a variety of conditions. For best results, the top of the antenna should have at least a partial view (unobstructed line of sight) of the sky. However, the view of the sky may be through a window and the antenna may be mounted indoors if the roof or upper floors do not shield the signal. Bench testing is recommended before the permanent location for the antenna is decided.

One of the main concerns when using a GPS receiver (Master Clock) is the distance between the antenna and the receiver. The ES-102 Antenna is supplied with 16’ 5” of RG-58 coax cable which can be connected directly to the clock. If more cable is required an in-line amplifier may be required.

When extra cable is required, several options exist. The most simple and least expensive methods are discussed below. It is, however, the ultimate responsibility of the end-user to decide which method will best satisfy the specific situation. Please feel free to contact the ESE factory for assistance.

Also... please read the section below which discusses the tests performed at ESE.

CABLING SUGGESTIONS / ALTERNATIVES

Method 1 (low loss cable)

Several types of "low loss" coax cable are available including RG-8 and RG-213. Using any of these types of cable "may" allow up to 300' of additional cable to be added to the 16’ 5” supplied with the antenna. Both RG-8 and RG-213 are expensive (relative to RG-58) and are cumbersome to work with due to their larger diameter.

Method 2 (in-line amplifier)

The use of an in-line amplifier such as the LA-12F (manufactured by Raven and available from ESE) may be more convenient than low loss cable. Installing one of these amps "may" allow up to 150' of RG-58 (or 300' of RG-8/RG-213) to be added to the 16’ 5” supplied. The LA-12FN has 'N' connectors which allow for convenient interconnections with RG-8 and RG-213 cable. See Figure 2 on page 6.

Method 3 (in-line amplifiers with power divider)

Due to the power limitations of the ES-102's receiver and antenna, only one in-line amplifier can be used. However, if a power divider such as the ES-AB1A is used, up to five (5) in-line amplifiers may be added. The more amplifiers used, the shorter the cable run between amps. See Figure 3 on page 6.

ESE TEST RESULTS

The methods mentioned above are conclusions based upon actual tests performed by ESE and on information provided by various manufacturers. The performance of your unit may differ due to antenna position and obstructions to its line of sight, weather/atmospheric conditions, cable length or signal reflections.

Listed below are the best consistent and repeatable performances. That is, they were repeatable performances on a consistent basis... not just fluke observations.

Caution is recommended: as the GPS Satellites age, their signal strength may decrease and today's cable length could cause undesirable results at a later date.

The ESE factory conducted several tests which demonstrate how the ES-102's Antenna can be expected to operate for given sets of circumstances. All tests were conducted at ESE (in El Segundo, CA) in 1998 and due to the architecture of the GPS Satellite Constellation, can be considered applicable most anywhere in the world.

Test 1
The first test shows that up to 112' of RG-58 cable can be added to the 16' 5" without any significant loss in signal. (Adding 125' impaired the clock's performance.)

Test 2
When using a single LA-12F, in-line amplifier with 150' of RG-58 cable (in addition to the 16' 5" supplied), the clock would "lock-on" in a nominal amount of time. (Adding 175' impaired the clock's performance.)

Test 3
Using an ES-AB1A (power divider) and two (2) LA-12F with 100' of RG-58 cable attached to each (216' 5" total) permitted the clock to "lock-on" in a nominal amount of time. Adding a third LA-12F with 75' of RG-58 cable did not impair the clock's performance, however, increasing the 75' to 100' did impair the clock's performance.

Test 4
Using an ES-AB1A (power divider) and four (4) LA-12F with 75' of RG-58 cable attached to each (316' 5" total) permitted the clock to "lock-on" in a nominal amount of time. Adding a fifth LA-12F with 25' of RG-58 cable also permitted the clock to "lock-on" in a nominal amount of time. Increasing the 25' to 50' impaired the clock's performance.

All of the tests mentioned above were conducted twice; first with the antenna indoors and second with the antenna outdoors. (Indoors refers to the ESE factory which is a single story building with a wood ceiling and asphalt composite roofing. And outdoors, the antenna had a very narrow look at the sky with approximately six feet of clearing between one-story buildings.)

In all cases, the ES-102 "Locked-on" within fifteen minutes, and in less time when the antenna was outside. ("Locked-on" refers to starting the clock from a completely "powered down" mode and the ESE Time Code output "catching" real-time with the "GPS Lock" LED lit.)

Various tests conducted away from the factory show that the exact unit which took five minutes to lock-on at the factory, may take up to 45 minutes at a different location. Possible explanations for this phenomenon lead us to believe that atmospheric conditions or poor antenna locations may be responsible.

APPLICATION NOTES

Application Note 1

ESE has noticed that the manufacturers' cable length specifications for the Motorola GPS Receiver and the Raven LA-12F differ from the test results of ESE. Please be aware that Motorola specs the maximum cable distance between the antenna and the receiver is 16’ 5” (5 meters) without amplification. Also, please be aware that Raven specs the maximum RG-58 cable that the LA-12F can drive is 50 feet.

ESE's test results may indicate that longer lengths of cable may be used. We are not inferring that the longer cable lengths should be used. We are only reporting the results of our tests and repeat the caution mentioned earlier.

Caution is recommended:

as the GPS Satellites age, their signal strength may decrease and excessive cable length may cause undesirable results.

Application Note 2

All ESE tests were conducted using RG-58 coax cable. According to several manufacturers of low loss cable, the signal loss attributable to cable length can be reduced with the use of "low loss" cable. According to the RG-8 and RG-213 cable specifications, when compared to RG-58, cable lengths may be doubled or more with "equal to" or "better than" results.

Application Note 3

Once an ES-102 has "Locked-on", the receiver creates a semi-permanent "Library" of where it expects to "see" a satellite(s) at a specific point in time. However, if after "Locking-on", the unit is relocated (for instance, from the ESE factory in California to an end-user's site in Europe), the unit's 1 PPS (and other outputs') accuracy may appear erratic for up to three hours. When the receiver has created an updated Library, all outputs will then comply with the specifications discussed in this manual.

MASTER CLOCK SOFTWARE - Program Descriptions

The ES-102 is shipped with a CD that contains several "Setup" Programs. Some of those programs are discussed below. All programs are described in the "Readme" file. It is suggested that one refer to the "Readme" file as it may contain updates issued after this manual was published. This software is also available from our web-site at "**www.ESE-WEB.com**". The DOS programs described below do not need to be used if the Windows® programs are used. For Win 3.1, use the "16 Bit" programs. For Win 95/98/ME/NT/2000, use the "32 Bit" programs. The DOS programs are in the form of separate command-line utilities. For the Windows versions, run the Setup.exe program. After the Install Wizard runs, a shortcut to the executable file will appear in your Start Menu.

ESEGPS

This Windows® program synchronizes the computer system time to the Master Clock time, and provides a control panel for adjusting various Master Clock functions. This program may be used to reinitialize the receiver if necessary. This program opens as a "watch" icon in the System Tray. Click on this icon to open the Control Panel applet.

MASTER32

This Windows® program works with the ASCII time output (Format "A", "0" or "1"). It synchronizes the computer system time to the Master Clock time. This program opens as a "watch" icon in the System Tray. Click on this icon to open the Control Panel applet.

MCDOS.EXE

This DOS program will set the System Time and Date of a PC/Compatible computer from an ES-102 GPS Master Clock when the machine is booted up. The line "MCDOS" should be added to your AUTOEXEC.BAT file. The file MCDOS.EXE should be placed either in the root directory or where the current PATH can find it.

The program by default is set to use COM1. To set it to a different COM port, add the port number to the command line:

MCDOS /2

The MCDOS.EXE program may also be invoked from the DOS prompt to set the time whenever desired. If you are using the optional serial port command described above, you can make running the program easier by creating a batch file to run the program:

COPY CON:T.BAT <enter>
MCDOS /2 <enter>
F6 (the function key) <enter>

Now, just typing T <enter> will set the time.

GPSINI.EXE

This DOS program is used to initialize the Time Zone, Time Delay and Cable Delay Compensation values. The Time Delay factor is set to zero, and the Cable Compensation is set for 19 feet. Running the program will print full instructions on screen for setting the time zone.

GPSHIFT(x).EXE

These DOS programs are used set the ES-102 to provide an advanced or delayed time output. This can be useful in TV network situations to compensate for video satellite delays. The time is adjustable from 0 to +/- 400 milliseconds, in increments of 1 millisecond. Determine which COM port you have available and use GPSHIFT1.EXE for COM1: and GPSHIFT2.EXE for COM2:. To set a 1/4 second delay using COM1:, for example, type GPSHIFT1-250 then hit the ENTER key.

GPSCBL(x).EXE

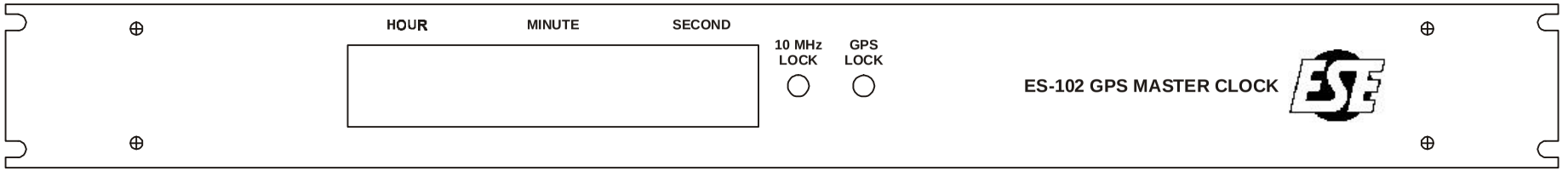
These DOS programs are used to compensate for antenna cable delay, adjustable from 0 - 22215 feet. Determine which COM port you have available and use GPSCBL1.EXE for COM1: and GPSCBL2.EXE for COM2:. To compensate the unit for 200 feet using COM1:, for example, type GPSCBL1 200 then hit the ENTER key.

NOTE: All of these settings are remembered by the ES-102, even if powered down with the battery off.

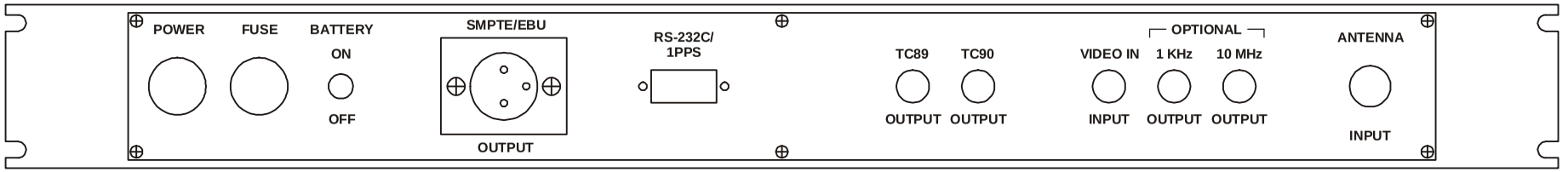
GPSTIME.EXE

This DOS program is used to set the Time and Date of the unit in the absence of a satellite signal.

ES-102
GPS MASTER CLOCK



The unit is shown with Option K.



ES-102 PARTS LIST

ES-101-M12 PCB COMPONENTS

QTY	DESIGNATION	DESCRIPTION	PART NUMBER
1	Z9	INTEGRATED CIRCUIT	4053 (PHILIPS)
1	Z8	INTEGRATED CIRCUIT	4503
1	Z7	INTEGRATED CIRCUIT	74HCT244
1	Z5	INTEGRATED CIRCUIT	LM1881N
1	Z6	INTEGRATED CIRCUIT	MAX 233CPP/ADM233LJM
1	Z10	INTEGRATED CIRCUIT	AD823AN
1	Z3	INTEGRATED CIRCUIT	DS87C520MCL-101M12
1	Z11	INTEGRATED CIRCUIT	LM2937ET-3.3
1	Z4	INTEGRATED CIRCUIT	32.0 MHZ VCTCXO
5	R14 - R18	RESISTOR	27 OHM 1/4W
1	R1	RESISTOR	75 OHM 1/2 W
1	R20	RESISTOR	330 OHM 1/4 W
2	R3, R4	RESISTOR	510 OHM 1/4 W
1	R22	RESISTOR	1.8K 1/4W
3	R21, R23, R25	RESISTOR	2.7K 1/4 W
2	R10, R11	RESISTOR	4.7K 1/4 W
1	R9	RESISTOR	10K 1/4 W
1	R8	RESISTOR	120K 1/4 W
1	R7	RESISTOR	470K 1/4 W
1	R2	RESISTOR	680K 1/4 W
1	R6	RESISTOR	1 MEGOHM 1/4 W
1	R5	RESISTOR	2.2 MEGOHM 1/4W
1	R24	RESISTOR	1K OHM mini pot
1	R12	RESISTOR	50K OHM mini pot
1	C16	CERAMIC CAPACITOR	47pf 50v Cer K
1	C15	CERAMIC CAPACITOR	.002uf 50v Cer Z
7	C7 - C12, C17	CERAMIC CAPACITOR	.1uf 50v Cer Z
1	C18	TANTALUM CAPACITOR	22uF TANTALUM
2	C13, C14	ELECTROLYTIC CAPACITOR	100uf 25v R El
1	T2	TRANSFORMER	429-7216
1	D4	GREEN LED	Green LED (T-1 3/4)
1		M12+ RECEIVER	P273T12N15
2		2X5 HEADER	SFMC-105-01-S-D
1		2X5 BOARD STACKER	FW-05-04-L-D-200-156
1		BATTERY	658-BR2330-1HE
1		8 POSITION DIP SWITCH	8 POS. DIP SWITCH
2		8 PIN DIP SOCKET	8 PIN DIP SOCKET
2		20 PIN DIP SOCKET	20 PIN DIP SOCKET
1		40 PIN DIP SOCKET	40 PIN DIP SOCKET
1		PCB	ES-M12BAT
1		PCB	ES-101-M12

ES-102 PARTS LIST (CONTINUED)

CHASSIS COMPONENTS

QTY	DESIGNATION	DESCRIPTION	PART NUMBER
1	T1	TRANSFORMER	P6465
1		D-SUB CONNECTOR	9 PIN MALE D-SUB
1		D-SUB CONNECTOR	9 PIN FEMALE D-SUB
1		D-SUB HOOD	9 PIN D-SUB HOOD
3		BNC	BNC (UG-1094)
1		XLR	XLR-3-32 (M)
1		ANTENNA	ANTENNA FOR GPS
1		GPS ANTENNA CABLE	GPS ANTENNA CABLE
1		CLIP AND LENS	CLIP & LENS FOR LED
1	F1	FUSE	1/2A FUSE
1		FUSE HOLDER	HTA FUSE HOLDER
1		3 WIRE BUSHING	3 WIRE BUSHING
1		LINE CORD	3 WIRE LINE CORD
1		CASE AND HARDWARE	ES-102

OPTIONAL COMPONENTS

QTY	DESIGNATION	DESCRIPTION	PART NUMBER
1	(ANT)	EMI ANTENNA	EMI ANTENNA
1	(ANT)	EMI ANTENNA CABLE	EMI ANTENNA CABLE
1	(BBU)	PC BOARD	ES-1424P
1	(DC)	FUSE	2 AMP FUSE
1	R19 (HR)	RESISTOR	2.2K 1/4 W
1	D3 (HR)	DIODE	1N4003
1	Q1 (HR)	TRANSISTOR	PN2907
1	K1 (HR)	RELAY	1A5A RELAY
1	(J)	TRANSFORMER	P8705/SSA5-6.3/230
1	(K)	PC BOARD	ES-110M12
1	(K)	M12+ TIMING RECEIVER	P283T12T12
1	(UL)	TRANSFORMER	AA-061A5-206
1	(UL)	UL POWER PLUG	UL PWR PLUG
1	(45 nS)	M12+ TIMING RECEIVER	P273T12T17

NOTE: THIS EQUIPMENT HAS BEEN TESTED AND FOUND TO COMPLY WITH THE LIMITS FOR A CLASS A DIGITAL DEVICE, PURSUANT TO PART 15 OF THE FCC RULES. THESE LIMITS ARE DESIGNED TO PROVIDE REASONABLE PROTECTION AGAINST HARMFUL INTERFERENCE WHEN THE EQUIPMENT IS OPERATED IN A COMMERCIAL ENVIRONMENT. THIS EQUIPMENT GENERATES, USES AND CAN RADIATE RADIO FREQUENCY ENERGY AND, IF NOT INSTALLED AND USED IN ACCORDANCE WITH THE INSTRUCTION MANUAL, MAY CAUSE HARMFUL INTERFERENCE TO RADIO COMMUNICATIONS. OPERATION OF THIS EQUIPMENT IN A RESIDENTIAL AREA IS LIKELY TO CAUSE HARMFUL INTERFERENCE IN WHICH CASE THE USER WILL BE REQUIRED TO CORRECT THE INTERFERENCE AT HIS OWN EXPENSE.

IF COMPONENT REMOVAL IS REQUIRED, WE RECOMMEND REMOVING ALL SOLDER USING A 35W OR SMALLER SOLDERING IRON AND SOLDER WICK TO PREVENT DAMAGE TO THE PRINTED CIRCUIT BOARD.

ALL INFORMATION CONTAINED IN THIS MANUAL IS SUBJECT TO CHANGE WITHOUT NOTICE.

ES-102 PARTS LIST (CONTINUED)

ES-USS PCB COMPONENTS

QTY	DESIGNATION	DESCRIPTION	PART NUMBER
1	Z6	INTEGRATED CIRCUIT	UCN5841A
1	Z5	INTEGRATED CIRCUIT	UCN5895A
1	Z1	INTEGRATED CIRCUIT	7805
1	Z2	INTEGRATED CIRCUIT	P87C51SBPN-USS1
1	X1	CRYSTAL	11.0592MHZ
7	R23 - R29	RESISTOR	47 OHM 1/4W
1	R30	RESISTOR	68 OHM 1/4 W
1	R2	RESISTOR	51K 1/4 W
1	R1	RESISTOR	120K 1/4 W
1	C12	CERAMIC CAPACITOR	10pf 50v Cer K
1	C13	CERAMIC CAPACITOR	25pf 50v Cer K
3	C5, C7, C8	CERAMIC CAPACITOR	.1uf 50v Cer Z
1	C14	ELECTROLYTIC CAPACITOR	4.7uf 10v R El
1	C6	ELECTROLYTIC CAPACITOR	10uf 16v LL R El
4	C1 - C4	ELECTROLYTIC CAPACITOR	3300 UF 25V
2	D1, D2	DIODE	1N4003
1	D3	DIODE	1N4148 or 1N914
1	Q1	TRANSISTOR	PN2222
1		HEAT SINK	300-TO220 HEAT SINK
1		8 POSITION DIP SWITCH	8 POS. DIP SWITCH
1		SOCKET	16 PIN DIP SOCKET
1		SOCKET	18 PIN DIP SOCKET
1		SOCKET	40 PIN DIP SOCKET
2		BRACKET	616 'L' BRACKET
3		LTD 6840Y	LED DISPLAY
1		PCB	ES-USS
1		PCB	ES-UCT2 DISPLAY

CHASSIS COMPONENTS

QTY	DESIGNATION	DESCRIPTION	PART NUMBER
2	T1, T2	TRANSFORMER	P6465

OPTIONAL COMPONENTS

QTY	DESIGNATION	DESCRIPTION	PART NUMBER
1	(DC)	DC/DC CONVERTER	1505D20UR
1	(DC/BBU) (12 - 18 V)	DC/DC CONVERTER	UM2804
1	(DC/BBU) (18 - 35 V)	DC/DC CONVERTER	1505D20UR

IF COMPONENT REMOVAL IS REQUIRED, WE RECOMMEND REMOVING ALL SOLDER USING A 35W OR SMALLER SOLDERING IRON AND SOLDER WICK TO PREVENT DAMAGE TO THE PRINTED CIRCUIT BOARD.

ALL INFORMATION CONTAINED IN THIS MANUAL IS SUBJECT TO CHANGE WITHOUT NOTICE.

OPTION K PARTS LIST

PCB COMPONENTS

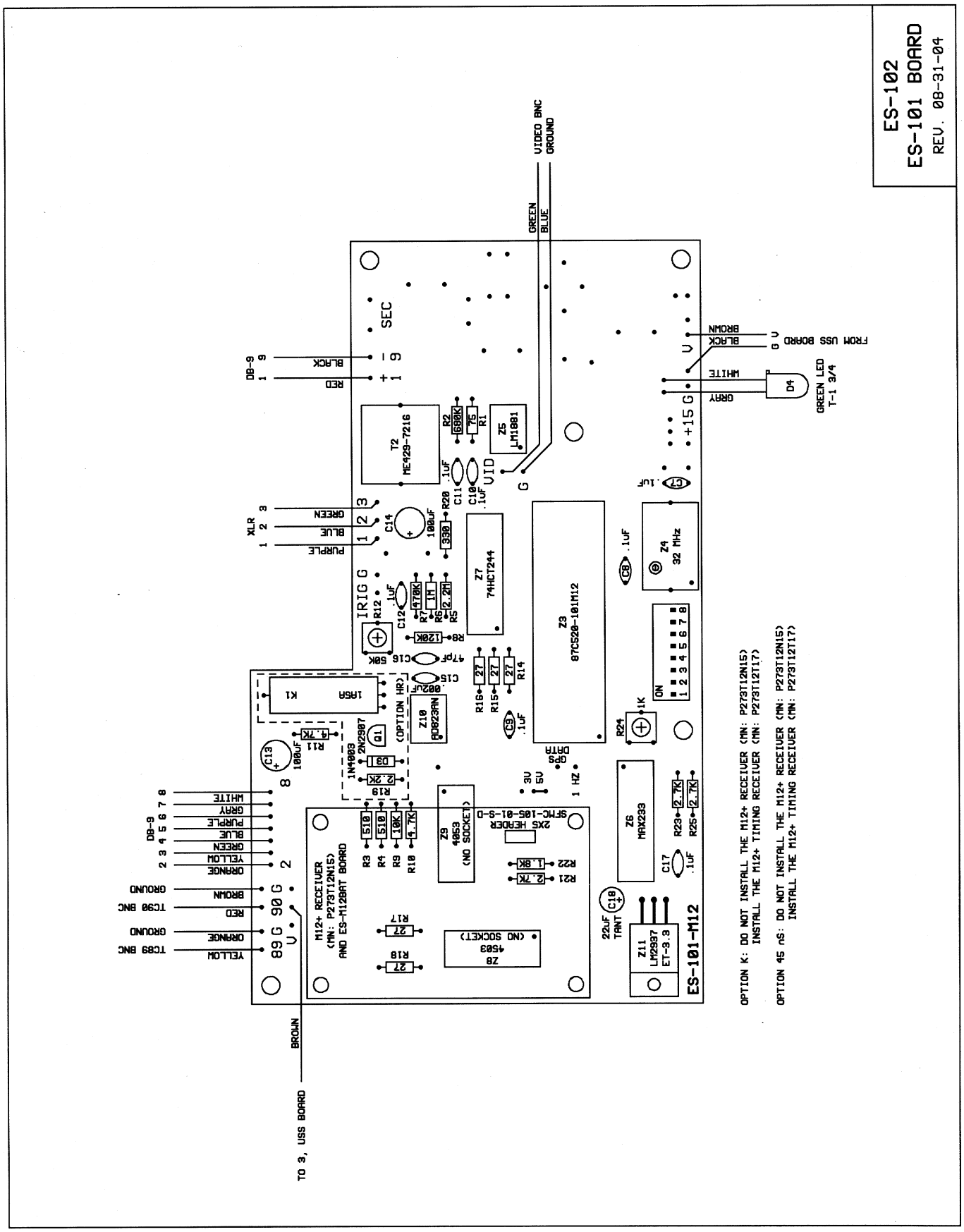
QTY	DESIGNATION	DESCRIPTION	PART NUMBER
1	Z1	INTEGRATED CIRCUIT	4503
1	Z2	INTEGRATED CIRCUIT	DS87C520MCL-110M12K
1	Z3	INTEGRATED CIRCUIT	74HCT4053 (PHIL)
1	Z4	INTEGRATED CIRCUIT	74HC4046
1	Z5	INTEGRATED CIRCUIT	74HCT93 (NO LS)
6	Z7 - Z12	INTEGRATED CIRCUIT	74HC161
1	Z13	INTEGRATED CIRCUIT	74HC14
1	Z14	INTEGRATED CIRCUIT	CLC 409AJP
1	Z16	INTEGRATED CIRCUIT	LMV7219
1	Z17	INTEGRATED CIRCUIT	AD823AN
1	Z6	OSCILLATOR	20.0 MHz OSCILLATOR
2	R3, R21	RESISTOR	10 OHM 1/4 W
3	R12, R13, R27	RESISTOR	27 OHM 1/4W
1	R2	RESISTOR	47 OHM 1/4W
1	R17	RESISTOR	100 OHM 1/4 W
1	R22	RESISTOR	330 OHM 1/4 W
1	R5	RESISTOR	390 OHM 1/4 W
1	R7	RESISTOR	510 OHM 1/4 W
2	R4, R16	RESISTOR	1K 1/4 W
5	R8, R14, R18 - R20	RESISTOR	10K 1/4 W
1	R15	RESISTOR	10 MEGOHM 1/4 W
1	R6	POTENTIOMETER	1K OHM mini pot
1	C21	CERAMIC CAPACITOR	47pf 50v Cer K
1	C15	CERAMIC CAPACITOR	.01uf 50v Cer Z
13	C1, C3 - C6, C8 - C14, C28	CERAMIC CAPACITOR	.1uf 50v Cer Z
2	C22, C23	POLY FILM CAPACITOR	4.7uF POLY FILM 100V
1	C29	ELECTROLYTIC CAPACITOR	10uf 16v LL R El
1	C2	ELECTROLYTIC CAPACITOR	1000uf 16v R El
1	C20	VARIABLE CAPACITOR	5-30 PF TRIMM 5MM V
1	D2	LED	Green LED (T-1 3/4)
1	D3	DIODE	1N4740
1	L1	INDUCTOR	3.3 uH INDUCTOR
1		SOCKET	8 PIN DIP SOCKET
2		SOCKET	14 PIN DIP SOCKET
9		SOCKET	16 PIN DIP SOCKET
1		SOCKET	40 PIN DIP SOCKET
1		PCB	ES-110M12

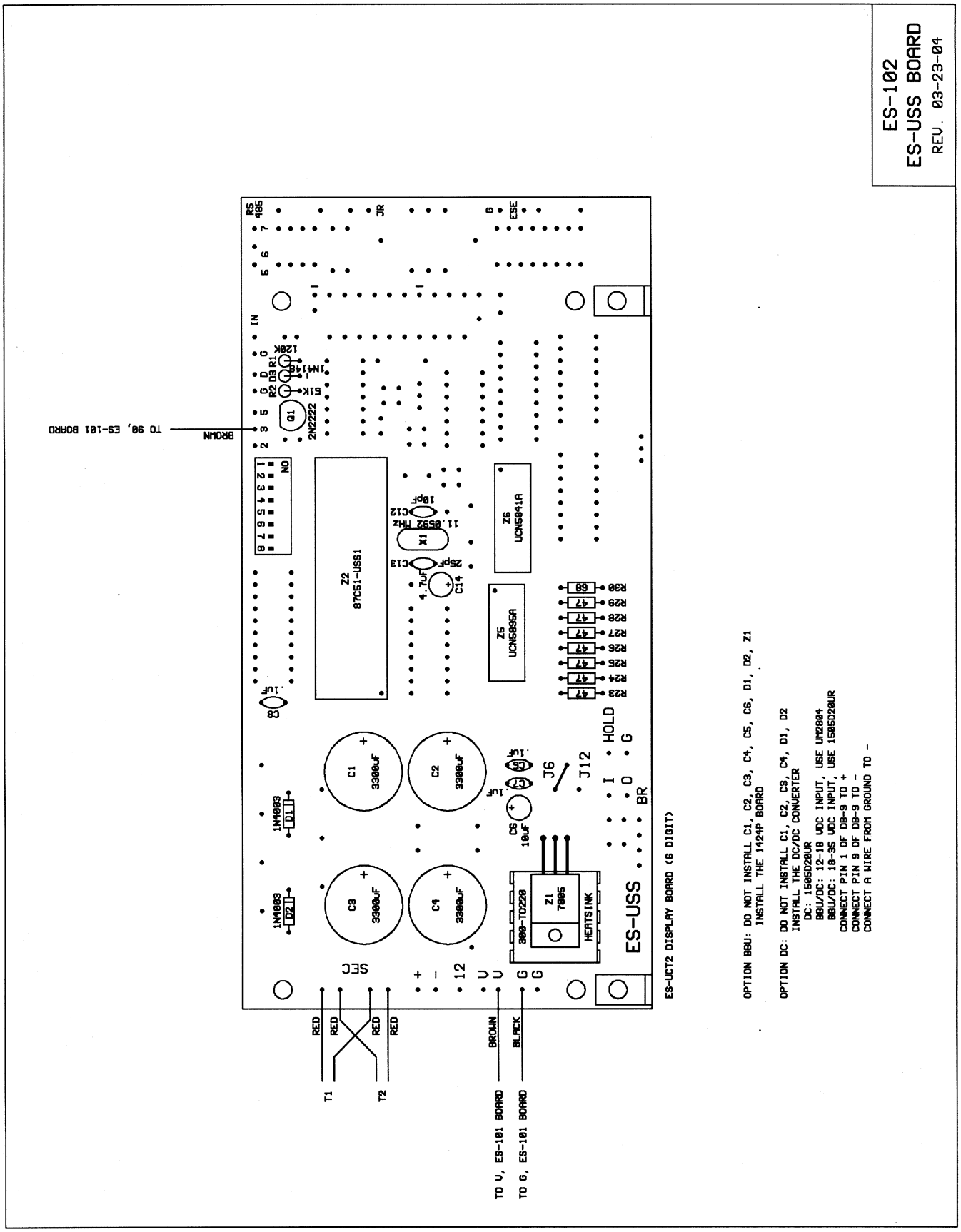
CHASSIS COMPONENTS

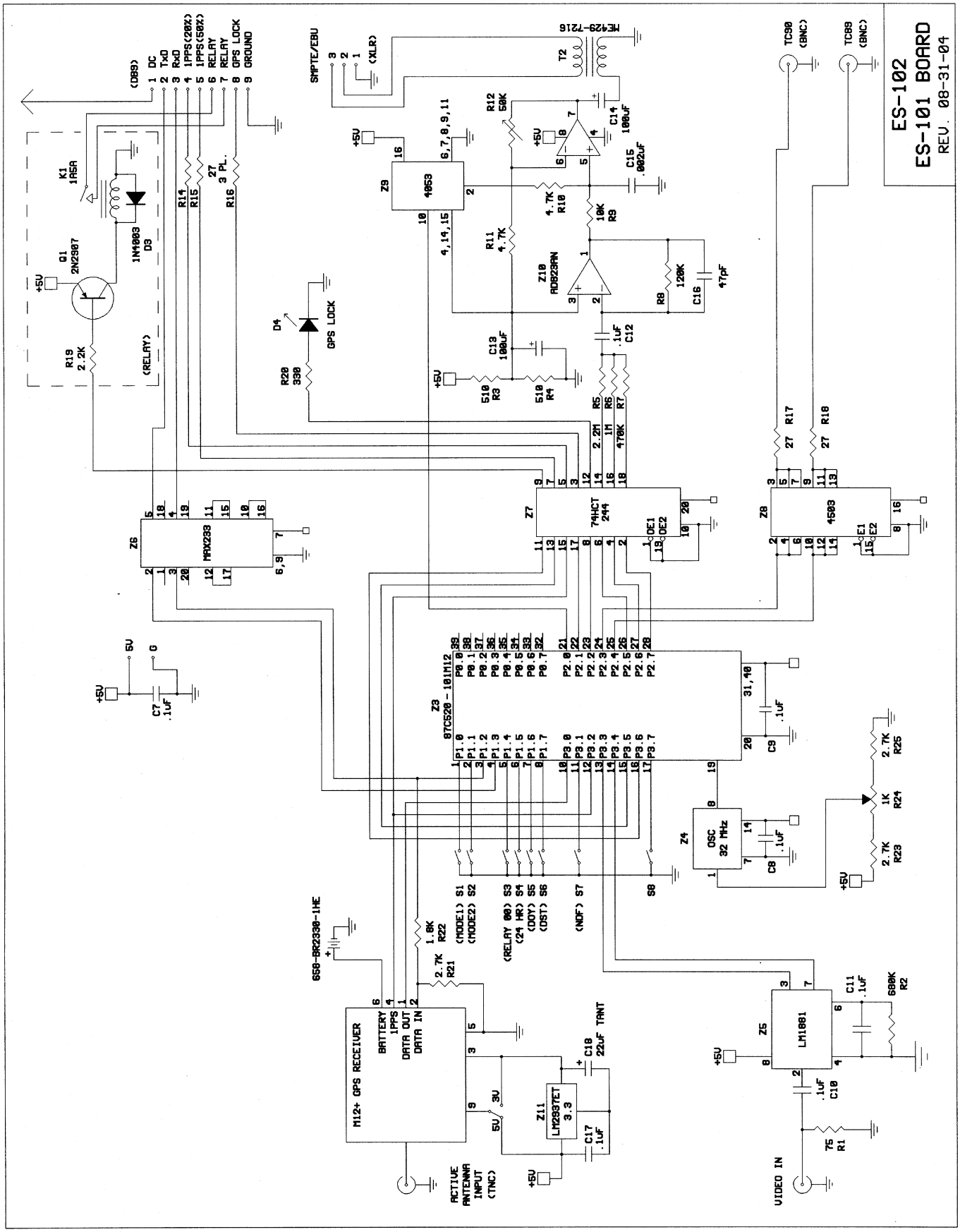
QTY	DESIGNATION	DESCRIPTION	PART NUMBER
1		CLIP & LENS FOR LED	CLIP & LENS FOR LED
2		CONNECTOR	BNC (UG-1094)

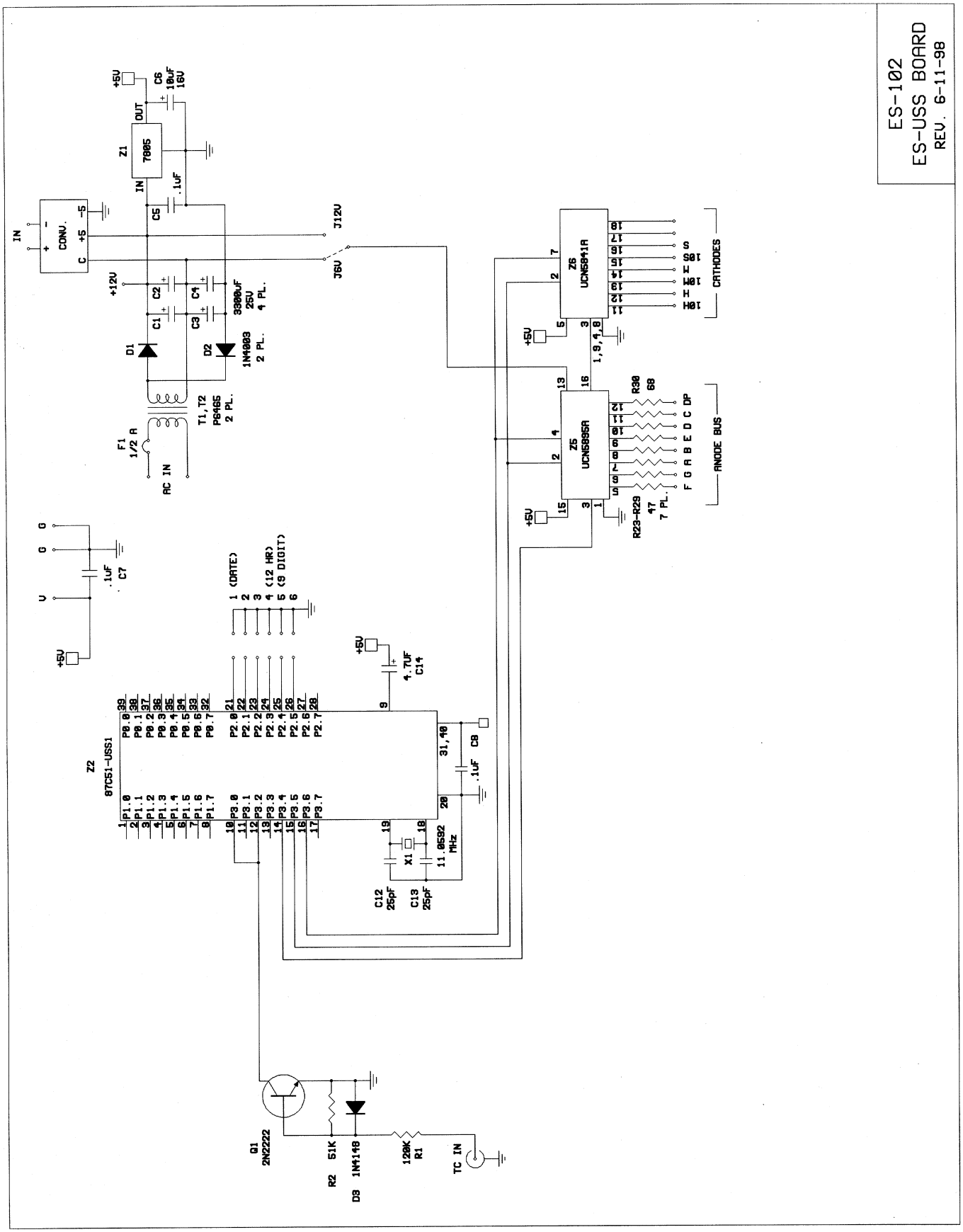
IF COMPONENT REMOVAL IS REQUIRED, WE RECOMMEND REMOVING ALL SOLDER USING A 35W OR SMALLER SOLDERING IRON AND SOLDER WICK TO PREVENT DAMAGE TO THE PRINTED CIRCUIT BOARD.

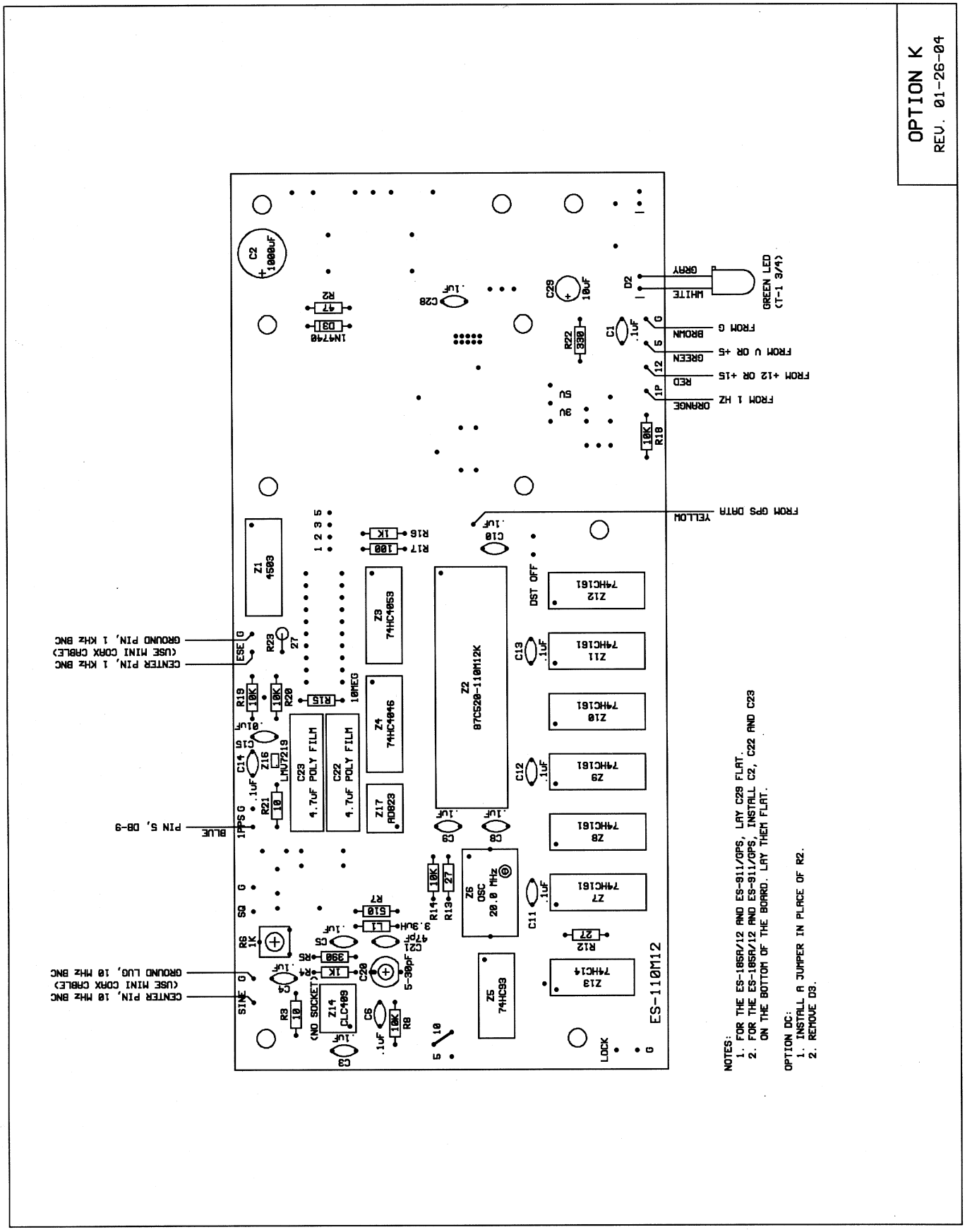
ALL INFORMATION CONTAINED IN THIS MANUAL IS SUBJECT TO CHANGE WITHOUT NOTICE.

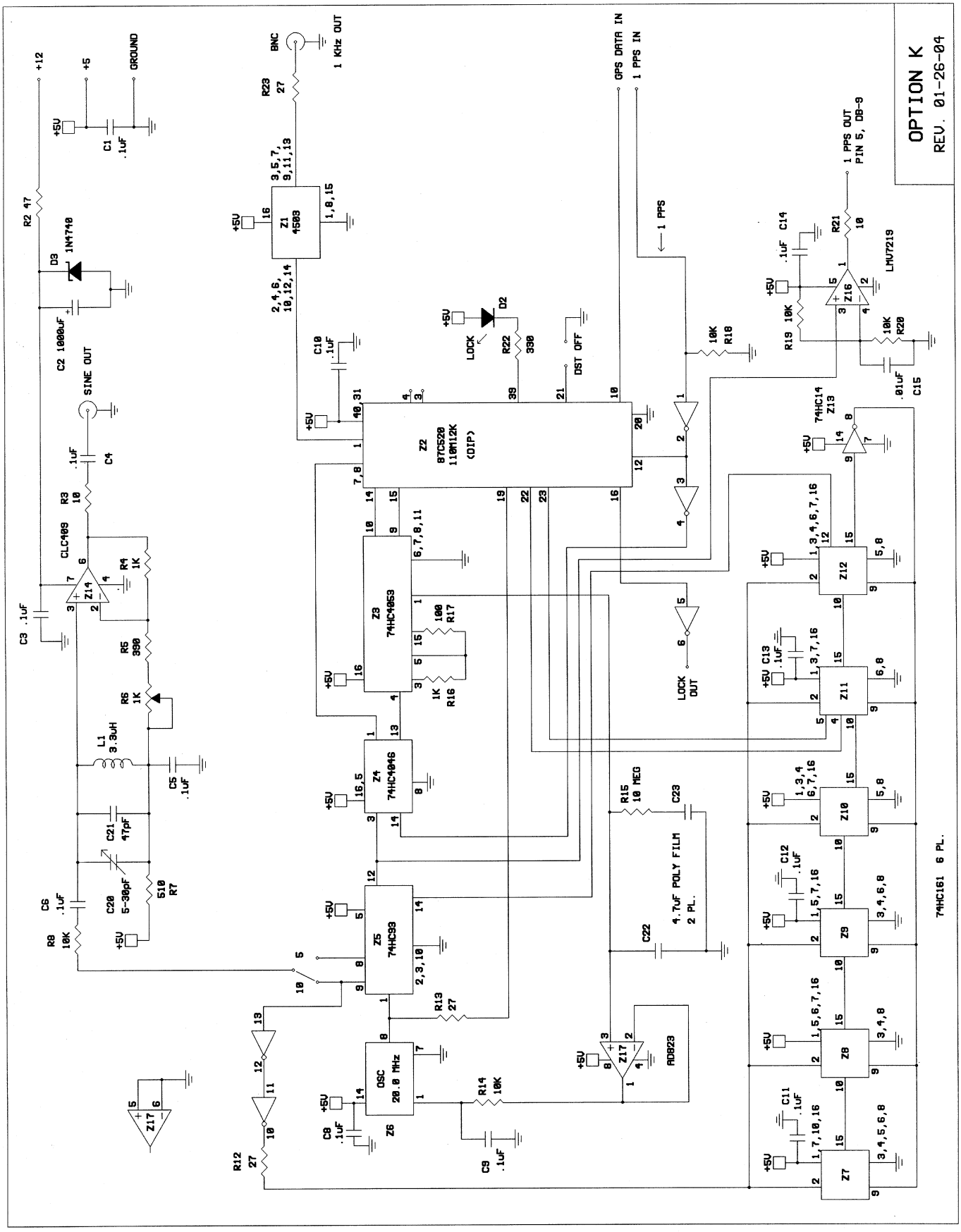

ES-102
ES-101 BOARD
REV. 08-31-04
ES-101-M12
M12+ RECEIVER
(MN: P273T12N15)
AND ES-M12BAT BOARD
OPTION K: DO NOT INSTALL THE M12+ RECEIVER (MN: P273T12N15)
INSTALL THE M12+ TIMING RECEIVER (MN: P273T12T17)
OPTION 45 nS: DO NOT INSTALL THE M12+ RECEIVER (MN: P273T12N15)
INSTALL THE M12+ TIMING RECEIVER (MN: P273T12T17)
VIDEO BNC
GROUND
GREEN
BLUE
FROM USS BOARD
BROWN
BLACK
WHITE
GRAY
GREEN LED
T-1 3/4
TO 3, USS BOARD
BROWN
DB-9
XLR
IRIG G
SEC
VID
+15 G
32 MHz
87C520-101M12
74HCT244
ME929-7216
LM1881
MAX233
LM2937
ET-3.3
SFMC-105-01-S-D
2X5 HEADER
(NO SOCKET)
ON
1 2 3 4 5 6 7 8
WHITE
GRAY
PURPLE
BLUE
GREEN
ORANGE
YELLOW
GROUND
BROWN
RED
TC90 BNC
GROUND
ORANGE
YELLOW
TC89 BNC


ES-102
ES-USS BOARD
REV. 03-23-04
TO 90, ES-101 BOARD
BROWN
ES-USS
ES-UCT2 DISPLAY BOARD (6 DIGIT)
SEC
12
V
V
G
G
HOLD
I
O
G
BR
J6
J12
Z1
7805
HEATSINK
300-TO220
Z2
87C51-USS1
Z5
UCN5895A
Z6
UCN5841A
X1
11.0592 MHz
C1
3300uF
C2
3300uF
C3
3300uF
C4
3300uF
C6
10uF
C12
18pF
C13
25pF
C14
4.7uF
D1
1N4003
D2
1N4003
Q1
2N2222
R1
12K
R2
51K
D3
1N4148
R23
R24
R25
R26
R27
R28
R29
R30
47
68
T1
T2
RED
RED
RED
RED
BROWN
BLACK
TO V, ES-101 BOARD
TO G, ES-101 BOARD
OPTION BBU: DO NOT INSTALL C1, C2, C3, C4, C5, C6, D1, D2, Z1
INSTALL THE 1424P BOARD
OPTION DC: DO NOT INSTALL C1, C2, C3, C4, D1, D2
INSTALL THE DC/DC CONVERTER
DC: 150SD20UR
BBU/DC: 12-18 VDC INPUT, USE UM2804
BBU/DC: 18-35 VDC INPUT, USE 150SD20UR
CONNECT PIN 1 OF DB-9 TO +
CONNECT PIN 9 OF DB-9 TO -
CONNECT A WIRE FROM GROUND TO -


ES-102
ES-101 BOARD
REV. 08-31-04
(DB9)
1 DC
2 TxD
3 RxD
4 1PPS(20X)
5 1PPS(50X)
6 RELAY
7 RELAY
8 GPS LOCK
9 GROUND
SMPTE/EBU
3
2
1
(XLR)
T2
ME429-7216
TC90
(BNC)
TC89
(BNC)
K1
1A5A
Q1
2N2907
D3
1N4003
R14
R15
27
3 PL.
R16
R19
2.2K
(RELAY)
+5V
D4
GPS LOCK
R20
330
Z9
4053
6,7,8,9,11
4,14,15
16
10
2
R12
50K
C14
100uF
C15
.002uF
R11
4.7K
R10
4.7K
R9
10K
Z10
AD823AN
R8
120K
C16
47pF
C13
100uF
C12
.1uF
R3
510
R4
510
R5
2.2M
R6
1M
R7
470K
Z7
74HCT
244
OE1
OE2
Z8
4503
E1
E2
R17
27
R18
27
Z6
MAX233
6,9
C7
.1uF
Z3
87C520-16IM12
P0.0
P0.1
P0.2
P0.3
P0.4
P0.5
P0.6
P0.7
P1.0
P1.1
P1.2
P1.3
P1.4
P1.5
P1.6
P1.7
P2.0
P2.1
P2.2
P2.3
P2.4
P2.5
P2.6
P2.7
P3.0
P3.1
P3.2
P3.3
P3.4
P3.5
P3.6
P3.7
31,40
20
C9
.1uF
Z4
OSC
32 MHz
C8
.1uF
R25
2.7K
R24
1K
R23
2.7K
S1
S2
S3
S4
S5
S6
S7
S8
(MODE1)
(MODE2)
(RELAY 00)
(24 HR)
(DOY)
(DST)
(NDF)
650-BR2330-1HE
R22
1.6K
R21
2.7K
M12+ GPS RECEIVER
BATTERY
1PPS
DATA OUT
DATA IN
ACTIVE
ANTENNA
INPUT
(TNC)
3V
C18
22uF TANT
Z11
LM2937ET
3.3
C17
.1uF
Z5
LM1881
C11
.1uF
C10
.1uF
R2
680K
R1
75
VIDEO IN


ES-102
ES-USS BOARD
REV. 6-11-98
+5V
C6
10uF
16V
Z1
7805
OUT
IN
.1uF
C5
IN
CONV.
+5
-5
C
+12V
C2
C4
C1
C3
3300UF
25V
4 PL.
D1
D2
1N4003
2 PL.
T1, T2
P6465
2 PL.
F1
1/2 A
AC IN
J12V
J6V
Z6
UCN5841A
CATHODES
Z5
UCN5895A
R30
68
ANODE BUS
R23-R29
47
7 PL.
1,9,4,8
+5V
.1uF
C7
1 (DATE)
4 (12 HR)
5 (9 DIGIT)
4.7UF
C14
Z2
87C51-USS1
P0.0
P0.1
P0.2
P0.3
P0.4
P0.5
P0.6
P0.7
P2.0
P2.1
P2.2
P2.3
P2.4
P2.5
P2.6
P2.7
P1.0
P1.1
P1.2
P1.3
P1.4
P1.5
P1.6
P1.7
P3.0
P3.1
P3.2
P3.3
P3.4
P3.5
P3.6
P3.7
31,40
C8
.1uF
X1
11.0592
MHz
C12
25pF
C13
25pF
Q1
2N2222
R2
51K
D3
1N4148
120K
R1
TC IN


OPTION K
REV. 01-26-04
ES-110M12
GREEN LED (T-1 3/4)
FROM G
FROM V OR +5
FROM +12 OR +15
FROM 1 HZ
FROM GPS DATA
CENTER PIN, 1 KHz BNC
GROUND PIN, 1 KHz BNC
CENTER PIN, 10 MHz BNC
GROUND LUG, 10 MHz BNC
PIN 5, DB-9
NOTES:
1. FOR THE ES-186R/12 AND ES-911/GPS, LAY C29 FLAT.
2. FOR THE ES-186R/12 AND ES-911/GPS, INSTALL C2, C22 AND C23 ON THE BOTTOM OF THE BOARD. LAY THEM FLAT.
OPTION DC:
1. INSTALL A JUMPER IN PLACE OF R2.
2. REMOVE D3.


OPTION K
REV. 01-26-04
74HC161 6 PL.
+12
+5
GROUND
SINE OUT
1 KHz OUT
BNC
GPS DATA IN
1 PPS IN
1 PPS
1 PPS OUT
PIN 5, DB-9
LOCK
DST OFF
LOCK OUT
4.7uF POLY FILM
2 PL.
87C520
11.0592K
(DIP)
74HC4053
74HC4046
74HC393
74HC14
CLC409
AD823
LMV7219
4538
OSC
20.0 MHz
1N4740
R2 47
C2 1000uF
C1 .1uF
R23 27
R22 330
R21 10
R19 10K
R20 10K
R18 10K
R15 10 MEG
R14 10K
R13 27
R12 27
R3 10
R4 1K
R5 390
R6 1K
R7 510
R8 10K
R16 1K
R17 100
C3 .1uF
C4 .1uF
C5 .1uF
C6 .1uF
C8 .1uF
C9 .1uF
C10 .1uF
C11 .1uF
C12 .1uF
C13 .1uF
C14 .1uF
C15 .01uF
C20 5-30pF
C21 47pF
C22
C23
L1 3.3uH
D2
D3
Z1
Z2
Z3
Z4
Z5
Z6
Z7
Z8
Z9
Z10
Z11
Z12
Z13
Z14
Z16
Z17